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SYMPOSIUM ON RESEARCH RELATED TO WATER POLLUTION IN THE NORTHWEST (3rd)

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THIRD SYMPOSIUM ON RESEARCH

RELATED TO WATER POLLUTION IN THE NORTHWEST

Arranged by E. F. Eldridge
U. S. Public Health Service
Portland, Oregon
April 4, 1958

Foreword

This series of informal symposium have been initiated for the purpose of encouraging cooperation between research entities in this area and to promote objective research in the field of water pollution. The first of the series provided an opportunity for those interested in research in this field to become acquainted with one another and the type of research in which each has an interest. Since the financing of research is a major problem, the second symposium was arranged with financing as its theme.

Agreeable to requests made by numerous members of the group attending the first meetings, future symposiums will deal with special subjects. Those interested in these special subjects will meet informally to discuss the work done or underway. It is hoped that this procedure will coordinate some of the effort placed on the problem and that the discussions will enhance the knowledge and competence of those attending. Every attempt will be made to keep the discussions on a scientific basis in order not to embarrass any specific entity.

Third Symposium

The third of the series of meetings was held to discuss the slime growth (Sphaerotilus) problem. All those known to have a scientific interest in this problem are invited to attend. A list of those in attendance and the entities represented is attached to this report of the meeting. The following is an abstract of the statements made by the various persons taking part in the discussions.

The Sphaerotilus Problem

The results of a study of the Lower Columbia and Willamette River problems were presented in brief. This was a cooperative project of the Washington Pollution Control Commission, Oregon State Sanitary Authority and the U. S. Public Health Service. Since these results will be compiled in a report which will be distributed to those attending the symposium, the material presented will not be discussed here.

Mention was made of the studies on the Columbia below Camas made

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by Crown Zellerbach Corporation. Also studies are presently being conducted by the National Council for Stream Improvement. The latter is to cover a full-year in order to determine the extant of the growth under varying river conditions (temperature, velocity, etc.).

The statement was made that there was very little growth with temperatures below 3°C, although there was definite growth at 4°C this year.

The growth is not associated with gross pollution.

The organism continues to thrive in the river even after it is detached.

The major problem involved is the interference with commercial and sports fishing by the large masses of growth which are floating or detached by the drift nets of the fishermen. There seems to be some evidence of other effects on the fish or fish eggs. The latter, however, has not been definitely established.

It was the opinion of some that the studies on the river represented an excellent start but that there was still need for further work, both in areas where the growth does not exist as well as those where it does.

The problem is not confined to the Lower Columbia River. Cannery wastes in eastern Washington are responsible for major growth problems. In the Walla Walla area wastes from three canneries have caused difficulties in irrigation projects. In this case the growths plugged pipelines, nozzles and ditches and even grew profusely in the fields under irrigation. The problem is under study by Washington State College. The principal difficulties are encountered during pea processing. Wastes from asparagus and corn do not seem to support a major growth.

Chlorination is to be tried as a means of control for the next season. The group felt that it would not be successful. Certain other chemical used in controlling growths in swimming pools will inhibit the growth, but may have objectionable toxic qualities. Removing the blancher waste may help to reduce the quantity of growth.

pH values below 5.0 and above 11.0 will prevent growth. The optimum pH is between 6.0 and 9.0.

Problems in other areas were mentioned briefly.

<u>The Organism</u>

The term "Sphaerotilus" includes a large association of organisms.

There is not a great deal of information in the literature concerning the organism.

There are apparently three forms. One is the slime form which is that causing the problems in the Columbia and Willamette Rivers. A second is a "pond" form which does not produce slime. The third is associated with iron in one form or another.

There is evidence that it may grow as a one-cell organism without sheath or slime formation. This may be the form in which it occurs in the Columbia above Camas. Also, it was found that it grew as a single cell in large concentrations of sulfite waste liquor from wood pulping. In reduced concentrations, it forms in multiple cells, produces a sheath and a mucilaginous substance. Apparently the organism adapts itself to its environment necessary to cause the organism to produce a sheath is not known.

Sphaerotilus is an aerobic organism. Its growth is inhibited by salt water. Ammonia also inhibits its growth. Major nutrient requirements are mono- and di-saccharides, organic acids (acetic and lactic), amino acids, nitrate nitrogen, organic nitrogen and phosphates. The hexos sugars appear to be more available than the pentos. The growth is proportional to the amount of food available. There is some question regarding the need for iron. Phosphate is a major factor controlling growth. The quantity required is small. The concentration of phosphate in the Columbia can vary 1000 fold. Algae seem to predominate when PO_4 is low. The average PO_4 of the Columbia has doubled since the Columbia Basin irrigation project was initiated, due perhaps to the increased use of fertilizers. There is a good chance that the development of the irrigated areas in this project will add further to the phosphate content of the lower river. Extremely small amounts (0.01 ppm) of phosphate are required to implement the growth of Sphaerotilus.

Wood sugars present in pulp mill cooking liquors are a major contributing factor to the growth in the area of the river below Camas. There appears to be no difference in the growth produced by the calcium or ammonium base cooking liquors indicating that the natural nitrogen content of the river is sufficient to support the growth.

The optimum temperature is 5° to 24°. However, the organism needs to adapt itself to major changes in temperature. Growth is more rapid at the higher temperatures. There has been a tendency for temperatures of the Columbia River to increase due to the formation of poolsby the construction of hydroelectric dams.

Residues from alcohol fermentation of sulfite waste liquor stimulate the growth of Sphaerotilus.

Current velocities influence growth. The growth seems to increase as the current increases. The effect of current was studied by applying the same bulk of nutrient under varying velocity conditions. The suggestion was made that it is desirable to determine the amount of nutrients required for each velocity. Such a study is being conducted locally by the National Council.

The quantity and availability of nutrients are controlled by the surface exposed to the water containing the nutrients. If the current is slow, the food is depleted on the water which is in contact with the surface and growth will be inhibited accordingly. High flows and velocities tend to spread the growing area.

Other Possible Influences

In addition to the physical interference to the fishing industry and sports fishery, there are other possible effects of the slime growths. Some of these effects may be biological, however, it is not definitely known what these effects may be. It is known that slime will reduce benthic organisms and has an influence on the biology of the stream Sphaerotilus can attach to other organisms and interfere with respiratory organs. Many forms seem to live in the slime growth, but may become entangled in the mass rather than preferring it as a habitat.

The dead organisms affect the oxygen level.

These growths are found in many areas and may have as important an effect on productivity of natural waters as other types of pollution.

If the growth occurred on a spawning bed it could smother the eggs. Salmon do not spawn just below Bonneville and above Washougal where there is no slime growth. Shad spawn in the lower river and especially in the vicinity of Washougal. There is a possibility that Sphaerotilus will attach itself to the eggs of shad, but there is no evidence that this occurs.

There must be a high velocity of water past the eggs in the spawning beds. The oxygen concentration must be 5ppm or more. Most of the water past the eggs, however comes from the gravel. Subsurface waters are more important than surface waters in the spawning next. It is possible that anaerobic conditions may exist in the area covered by Sphaerotilus especially if dead organisms are present.

Chum salmon at one time a large contributor to the commercial salmon take in the Columbia. Today it is very small. Young chum salmon emerge from the egg and drift downstream with the yolk sack still attached. This occurs in March and April. They could possibly become

entangled in the slime and be destroyed. This occurrence has not been observed.

The concensus of the group in this connection was that there were many possible effects of slime on fish and other aquatic organisms, but that there was little direct evidence regarding these effects. More studies in this connection should be made.

Requirements for Control

The requirements for the control of slime growths in the Lower Columbia will require a substantial investment on the part of the pulp industry. Sphaerotilus grows well in very small concentrations of sulfite waste liquor (17 ppm and less with carbohydrate content of 1.0 to 3.0 ppm based on 10% liquor). The problem, therefore, cannot be solved by mere dilution of the waste. Wastes from the kraft process and other mill effluents will also support the growth. It is not known if a reduction of 50 to 85 percent will alleviate the problem.

Many methods have been tried in an effort to find the answer. Bacterial fermentation appears to be the most effective, but if applied to the concentrated waste only it may not solve the river problem since the other effluents would still support the growth. Chemicals have been tried. They reduce the growth, but may be toxic to other life in the river.

Intermittent discharge of waste has been suggested. This would involve the storage of all effluents for a period (perhaps 5 days) and complete discharge during one day. This procedure would remove the constant supply of nutrients necessary for growth of the slime. It would increase the concentration of sulfite liquor solids by five or six times for the period of discharge. Whether or not the solids will be completely flushed from the river during the holding period will depend upon the flow time and will vary with the magnitude of the flow.

Future

It was agreed that the Sphaerotilus problem required further study. More information is needed regarding the effects of slime growths on stream productivity. There should be more effort on the part of fisheries agencies to develop the techniques by which these effects can be measured and to collect and document evidence regarding the relationship between the growth and productivity.

It was the consensus of the meeting that symposiums on special subjects such as the one being held were of definite value. More meetings of this type will, therefore, be arranged. Suggestions regarding subjects will be appreciated.

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